Summary of work activities
Daniel V. Thomas López
European Public Health Microbiology Training
Programme (EUPHEM), 2018 cohort

Background

According to the European Centre for Disease Prevention and Control (ECDC) Advisory Group on Public Health Microbiology ('national microbiology focal points'), public health microbiology is a cross-cutting area that spans the fields of human, animal, food, water, and environmental microbiology, with a focus on human population health and disease. Its primary function is to improve health in collaboration with other public health disciplines, in particular epidemiology. Public health microbiology laboratories play a central role in detection, monitoring, outbreak response and the provision of scientific evidence to prevent and control infectious diseases.

European preparedness for responding to new infectious disease threats requires a sustainable infrastructure capable of detecting, diagnosing, and controlling infectious disease problems, including the design of control strategies for the prevention and treatment of infections. A broad range of expertise, particularly in the fields of epidemiology and public health microbiology, is necessary to fulfil these requirements. Public health microbiology is required to provide access to experts in all relevant communicable diseases at the regional, national and international level in order to mount rapid responses to emerging health threats, plan appropriate prevention strategies, assess existing prevention disciplines, develop microbiological guidelines, evaluate/produce new diagnostic tools, arbitrate on risks from microbes or their products and provide pertinent information to policy makers from a microbiological perspective.

According to Articles 5 and 9 of ECDC's founding regulation (EC No 851/2004) 'the Centre shall, encourage cooperation between expert and reference laboratories, foster the development of sufficient capacity within the community for the diagnosis, detection, identification and characterisation of infectious agents which may threaten public health' and 'as appropriate, support and coordinate training programmes in order to assist Member States and the Commission to have sufficient numbers of trained specialists, in particular in epidemiological surveillance and field investigations, and to have a capability to define health measures to control disease outbreaks'.

Moreover, Article 47 of the Lisbon Treaty states that 'Member States shall, within the framework of a joint programme, encourage the exchange of young workers. 'Therefore, ECDC initiated the two-year EUPHEM training programme in 2008. EUPHEM is closely linked to the European Programme for Intervention Epidemiology Training (EPIET). Both EUPHEM and EPIET are considered 'specialist pathways' of the two-year ECDC fellowship programme for applied disease prevention and control.

This report summarises the work activities undertaken by **Daniel V. Thomas López**, cohort **2018** of the European Public Health Microbiology Training Programme (EUPHEM) at the **Statens Serum Institut (SSI)** of Denmark.

All EUPHEM activities aim to address different aspects of public health microbiology and underline the various roles of public health laboratory scientists within public health systems.

Pre-fellowship short biography

Daniel V. Thomas López completed his Veterinary medicine degree in 2011 at the Complutense University of Madrid, Spain. He carried out research stays at different institutions in France and the United Kingdom. In 2017, he achieved his PhD on Molecular biology, Biochemistry & Biomedicine, in the field of antimicrobial resistance (AMR). Afterwards, he was invited to lecture at the University for Development Studies of Ghana. In 2018, he carried out a traineeship at the European Food Safety Authority (EFSA), working on the evaluation of projects and the benchmarking of bioinformatics tools. Immediately afterwards, he started his EUPHEM program at SSI, in September 2018.

Daniel has always been interested in the fields of global health and One Health, as well as in the areas of capacity building, management and communication. Therefore, the EUPHEM fellowship represented a unique opportunity due to its holistic approach.

Methods

This report accompanies a portfolio that demonstrates the competencies acquired during the EUPHEM fellowship by working on various projects, activities and theoretical training modules.

Projects included epidemiological investigations (outbreaks and surveillance); applied public health research; applied public health microbiology and laboratory investigation; biorisk management; quality management; teaching and public health microbiology management; summarising and communicating scientific evidence and activities with a specific microbiological focus.

The outcomes include publications, presentations, posters, reports and teaching materials prepared by the fellow. The portfolio presents a summary of all work activities conducted by the fellow, unless prohibited due to confidentiality regulations.

Results

The objectives of these core competency domains were achieved partly through project or activity work and partly through participation in the training modules. Results are presented in accordance with the EUPHEM core competencies, as set out in the EUPHEM scientific guide[1].

1. Epidemiological investigations

1.1. Outbreak investigations

Supervisors: Pikka Jokelainen, Lasse Skafte Vestergaard, Luise Müller, Rune Stensvold

Recurring Cryptosporidium outbreaks in veterinary students
In September 2018, the Statens Serum Institut (SSI) was contacted by the University of Copenhagen regarding a possible outbreak of cryptosporidiosis among veterinary students. Similar outbreaks, in relation to the students performing fetotomy exercises, had been suspected in the last years and one outbreak was investigated in 2012. Additionally, similar outbreaks have been reported in other countries.

The students attend this training in groups of ten students. Upon the reported outbreak in one of the groups in September 2018, a one-year prospective cohort investigation was initiated, in order to identify risk factors and provide guidance for preventing the recurrent outbreaks. During the study, another outbreak took place in January 2019.

Experts from SSI carried out two site visits to observe the exercises, in order to identify possible risk factors and flaws in the preventive measures. Students that attended the fetotomy exercise completed a questionnaire about symptoms and potential risk behaviour. Those students suffering symptoms were encouraged to submit a stool sample for analysis. Additionally, the investigation included analysing the faecal samples – which were being

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[1] European Centre for Disease Prevention and Control. European public health training programme. Stockholm: ECDC; 2013. Available from: http://ecdc.europa.eu/en/publications/Publications/microbiology-public-health-training-programme.pdf

collected and stored by the University – from all calves used for the exercises since January 2018. Real-time PCR was used to detect *Cryptosporidium* spp. in the samples and to quantify the faecal parasite load in the calves. Positive samples were genotyped by nested PCR targeting the gp60 locus.

Altogether, 97 students attended the fetotomy exercise between September 2018 and June 2019. Eleven cases (11.3%) were identified in the two outbreaks, with attack rates of 4/10 (40%) and 7/9 (78%) attack rates. The risk factors identified were handling a calf with diarrhoea (all cases; *p* value=0.02), having visible faecal contamination on the personal protective equipment (PPE) (RR: 11.3; 1.5–85.6) and having problems with the PPE (RR: 4.6; 1.1–20.2). Using soap, and not only alcohol gel, for hand washing, appeared as a protective factor.

Of the 94 calves used for the exercises, 12% of those younger than seven days of age were positive for *C. parvum*, in contrast with 67% of those aged seven days and above. A high faecal parasite load in a calf was associated with a higher probability of an outbreak occurring among the students (RR: 5.38; 1.87–15.50). *C. parvum* genotype IIaA15G2R1 was detected in both students and calves.

Our investigation showed the high risk of contracting cryptosporidiosis among veterinary students handling infected calves, and a dose-dependent relationship with the level of infection of the calves handled. Avoiding the use of infected calves is the primary recommendation. Additionally, students should be properly trained in the use of PPE and hygiene measures.

The fellow was the principal investigator of this outbreak. He participated in one of the site visits, in the design of the questionnaire for the students and in the drafting of recommendations for the University. He performed (wet and dry) laboratory work (see section 3), he carried out the epidemiological analysis and coordinated communication and meetings with the rest of the team (see section 7). He also prepared the outbreak report, drafted the manuscript and presented communications of this outbreak in different fora (SSI presentations, lectures to students, ESCAIDE, etc.).

An outbreak at Copenhagen airport on New Year's Eve

On the evening of the 31st of December, a canteen delivered 300 servings of a New Year's menu for the employees of several departments at Copenhagen airport. The menu was packed in disposable trays, and some of the dishes shared the same tray. On the next days, cases of gastrointestinal illness were reported in three of the departments and an outbreak investigation was initiated by the local food authorities. A cohort study was carried out, using a questionnaire and calculating risk ratios (RR) with 95% confidence intervals (CI).

In total, 63 people completed the questionnaire and 36 respondents met the case definition. The symptoms more frequently reported were diarrhoea and abdominal pain. The median incubation time was 10.5 hours (range 1½ hours – 1 day, 22 hours, 45 minutes). The median duration of disease was 1.4 days, ranging from a few hours to 5 days.

In a univariable analysis, eating the New Year's menu was a risk for becoming sick (*p* value<0.01, all cases exposed). A particular food item did not stand out as a significant risk. This can be explained by the fact that the dinner was served as a pack and, therefore, most individuals were exposed to the same food items. However, those who ate the meat dish and its sauce had a three time higher risk of illness compared with – the few – who did not eat this. Additionally, in the comments, some people mentioned that the meat was not properly cooked.

In the absence of pathogen confirmation, considering the reported symptoms and the low incubation period, it is likely that the involved agent was a spore forming bacteria.

Together with an EPIET fellow, the EUPHEM fellow carried out the questionnaire data cleaning, descriptive analysis and univariable analysis. He also prepared the report for the local food authorities.

COVID-19 pandemic response

As part of the COVID-19 international response, during eight weeks the fellow was deployed to the Incident Management System team in the WHO-EURO office, located in Copenhagen. Here, he carried out tasks related to surveillance, analysis of the physical distancing measures implemented by the different countries and liaison with the national contact points to establish the epidemiological situation of the countries according to the WHO classification.

Additionally, he supported the SSI by attending meetings and providing input on different aspects, such as visualization strategies to display information on the testing activity of the country.

Training modules

During the ECDC Fellowship Introductory Course, the participants were lectured in the basic concepts of outbreak investigation, epidemiological and microbiological analysis. In the Outbreak Investigation module, the fellows were trained in depth in the ten steps of outbreak investigation and in the use of different software. They practiced data collection, cleaning and management, as well as descriptive, univariable and stratified analysis. The fellow participated as well in lectures and case studies about microbiological methods and the use of whole genome sequencing (WGS).

The Multivariable Analysis module trained the fellows in further analytical skills that were valuable for the outbreak investigations in which the fellow was involved. The Management, Leadership and Communication module taught the fellows how to engage with the different stakeholders involved in outbreaks and emergencies.

Educational outcome: overall, the fellow applied the ten steps of outbreak investigation in the different tasks he was involved. He applied and expanded his skills in microbiology and epidemiology. Additionally, the outbreak investigations further developed his skills in management, team leading and communication with different stakeholders, at the same time that he contributed to scientific manuscripts and reports drafting and publishing.

1.2. Surveillance

Supervisors: Søren Anker Uldum, Charlotte Kjelsø, Ramona Trebbien, Hanne-Dorthe Emborg, Johanna Takkinen, Aftab Jasir

Determination of the age-specific notification rates of Legionnaires' Disease in Danish provinces, 2015-2018

Legionnaires' disease (LD) incidence has been increasing in several European countries since 2011. Denmark experiences one of the highest annual incidences of LD despite its small country size, cold climate and homogenous population, and the incidence differs notably across the country. The aim of this project was to determine if provincial differences in LD incidence are due to the age and sex distribution of the population, and to characterise the risk of LD by province and age group in Denmark.

The incidence of LD by province and year was assessed using national routine surveillance data for domestic LD cases collected between 2015 and 2018. Poisson regression models were fit to understand the risk of LD by year and province, as well as by 5-year age grouping.

It was found that the incidence of domestic LD increased 49% between 2015 and 2018 across Denmark. Some provinces continuously had high incidence of disease, even after adjusting for yearly trends and the underlying population distribution. Fluctuations in the population above age 65 years was not responsible for the increase in disease in the analysis. Finally, incidence of disease increased with increasing 5-year age group in both males and females.

The relative differences in incidence between different Danish provinces could not be explained by the age and sex distribution of the population, meaning that other factors must be responsible for the different incidence across the country. These results may help to interpret trends in other countries experiencing unexplained high incidence of LD in the EU.

The fellow was the principal co-investigator of this project. He carried out the data management and descriptive analysis. He wrote the entire report for SSI, which was used as initial draft for the manuscript. He also participated in the preparation of the article for the EPINEWS monthly bulletin on LD.

Surveillance of seasonal influenza in Denmark, 2019-2020

In Europe, influenza is responsible for up to 70,000 deaths each year. In Denmark alone, influenza caused 11,000 laboratory confirmed cases and 800 deaths in the 2018-2019 season. As different influenza subtypes circulate every season, surveillance is crucial to detect promptly unusual events in terms of timing, excess in morbidity and/or mortality, coverage and efficacy of the vaccine. These data must be shared timely with other countries to ensure proper handling and containment of the disease.

National epidemiological and microbiological surveillance of influenza in Denmark is conducted at National Influenza Centre (NIC) of the SSI. The NIC receives samples from two sources: general practitioners submit samples from patients with influenza like illness (conforming the sentinel system), and regional clinical microbiological departments submit influenza virus-positive diagnostic samples, a subset of which, are included for real-time subtyping at the NIC during the influenza season. Of all subtyped samples, a further subset is selected for WGS. The national surveillance is further based on different national registries: information about all microbiological tests and results are extracted from the National microbiological database (MiBa), vaccination with influenza vaccines is registered at individual level in the Danish Vaccination register, and hospitalisations and underlying chronic diseases is defined based on the National Discharge register.

In this project, the fellow carried out the influenza season monitoring and surveillance, analysing WGS and phylogenetics data using different software. Vaccine effectiveness studies were performed based on harmonized data from the above mentioned registers. Metadata templates were used to report to TESSy and GISAID on data about circulating variants and mutations associated with a different vaccine effectiveness. The fellow prepared a script to automatize the reporting process.

A peer-reviewed article about the interim influenza vaccine effectiveness in several European countries during the 2019-2020 season was published, to which the fellow contributed by producing the above mentioned data and by revising the draft manuscript to give input.

Survey on the national surveillance systems for vibriosis and Shewanella spp. infections in EU/EEA countries

In order to achieve an overview of countries in the European Union (EU) and the EEA who have or are planning to implement surveillance systems for vibriosis and/or for *Shewanella* infections, an online survey was conducted by the fellows during September and October 2019. It was disseminated to the National Focal Points for Food- and Waterborne Diseases and Zoonoses (FWD) of the EU/EEA countries through the Epidemic Intelligence Information System for FWD. The main objective of the survey was to collect information about national surveillance systems on vibriosis (including all *Vibrio* other than toxin producing *Vibrio cholerae* O1 and O139 as causative agents) and *Shewanella* spp. infections.

Twenty four out of 31 EU/EEA countries replied to the survey leading to a response rate of 77%. All participating countries replied to both parts of the survey. Ten countries stated they had a surveillance for vibriosis in place. The extent of surveillance activities varied from comprehensive mandatory notification of any type of vibriosis infection to more focused syndromic surveillance of food-poisoning and gastro-enterocolitis. None of the other countries planned to introduce a surveillance system for vibriosis in the next two years. Two EU/EEA countries had a surveillance system for *Shewanella* spp. infections in place. An additional EU/EEA country intended to introduce such a surveillance system within one year. None of the other countries had plans to establish such a surveillance system in the near future.

Answers also indicated ongoing national and international research projects underlining the public health interest in vibriosis and *Shewanella* spp. infections. The collected data will be useful to ECDC and EU/EEA countries where an assessment for the future introduction of a surveillance system for these pathogens is planned.

This project was a collaboration of the four EUPHEM fellows involved in the multi-country research project on *Vibrio* infections (Ettore Amato, Maximilian Riess, Daniel V. Thomas López and Marius Linkevicius). The fellows designed the survey, collected and analysed the data and wrote a technical report that was delivered to the ECDC.

Training modules
The Introductory Course included training on types of surveillance systems, data collection and data analysis. Other modules, such as the Outbreak Investigation Module, trained the fellow on how to handle and operate with datasets.

Educational outcome: the fellow learnt how to analyse surveillance data and how to handle and merge datasets from different sources. He was able to identify limitations in the surveillance systems as well as solutions that can be implemented to fill these gaps in knowledge.

2. Applied public health microbiology research

Supervisors: Kurt Fuursted, Maria Wessman, Susan Cowan

Multi-country occurrence of *Vibrio* infections other than cholera in Nordic countries in 2018

Vibrio is a genus of ubiquitous bacteria found in a wide variety of fresh water and marine habitats. Non-cholera *Vibrio* species most commonly cause self-limited gastroenteritis or mild extraintestinal symptoms, with the exception of *V. vulnificus*, an opportunistic pathogen with a high mortality rate as it causes wound infections that can rapidly lead to septicaemia and necrotizing fasciitis.

Global warming, in particular rapid warming of coastal regions caused by climate change, is likely to greatly expand the geographical extent and effects of pathogenic *Vibrio* spp., as several studies have shown. In the last years, Countries in northern Europe have witnessed an increase in *Vibrio* infections during heatwaves, including 2018, when remote sensing maps from ECDC showed high water temperatures (>20°C) and conditions consistent with *Vibrio* growth in seawater along the coast of Baltic and Nordic countries.

A notable data gap in the field is the availability of surveillance data at a global level, regarding *Vibrio* infections causing symptoms other than cholera, as these infections are not notifiable in most countries. For these reasons, a joint epidemiological and microbiological project between EUPHEM fellows based in Denmark, Norway, Sweden and Finland was established, with the collaboration or other neighbouring countries. The aim was to describe the epidemiology of domestic *Vibrio* infections in countries bordering the North and Baltic Sea in 2018. The fellows conducted a retrospective cross-sectional study using laboratory-based or passive surveillance data, analysing demographics, geographical distribution, seasonality and severity of vibriosis cases. WGS was carried out in order to elucidate the relatedness of isolates and to determine virulence, biofilm and AMR determinants present in the studied isolates.

The results of the study showed that more male than female individuals had been infected. The cases developing severe infections had higher chances of being above 65 years old, being infected in summer and by the species *V. vulnificus* and *V. parahaemolyticus*.

Through WGS, a wide range of virulence and AMR genes were identified in the isolates. Although phylogenetic analysis showed diversity between *Vibrio* isolates, two major *V. vulnificus* clusters (<10 SNPs) were identified in Norway and Sweden.

The results of this project will be valuable for proposing public health recommendations and control measures, such as establishing surveillance systems to monitor the presence of *Vibrio* in recreational waters and create awareness among vulnerable populations.

The fellow was principal investigator of the project in Denmark. He contributed in equal terms to the design of the project, the research protocol and the manuscript. He collected the WGS data and the epidemiological information from the Danish isolates. He was particularly involved in the development of the WGS pipeline as well as in the virulence and AMR analysis.

Overlapping of transmission clusters in both HIV-positive and *N. gonorrhoeae* positive individuals

In Denmark, free access to effective antiretroviral treatment for HIV, combined with the recent introduction of PrEP (pre-exposure prophylaxis), have led to a decrease in the use of condom, in particular among the MSM (men who have sex with men) population. This is the likely reason to explain the increase in the incidence of other sexually transmitted infections (STI). *Neisseria gonorrhoeae* stands out as one of the rising STI of major concerns globally, in particular because of its AMR relevance.

Phylogenetic analysis of HIV transmission clusters have proved efficient to understand the epidemiology of HIV transmission in the population. Based on previous studies, it is expected that there are overlapping clusters between individuals infected with HIV and those infected with *N. gonorrhoeae*. Therefore, it is expected that combining HIV phylogeny and *N. gonorrhoeae* phylogeny should be useful to understand the transmission networks and patterns and to identify target groups for intervention in Denmark.

An observational retrospective study was carried out, with the aim of understanding the dissemination of STI among the HIV positive population. The study included microbiological and epidemiological data from the period 2010-2020 stored at the National microbiological database (MiBa) and at the National surveillance registry. Information on age, sexual orientation, mode of HIV transmission, time of HIV diagnosis and country of HIV transmission was extracted. For estimating HIV transmission clusters between Danish patients, sequences from the HIV-1 *pol* gene, routinely used in HIV phylogenetic analyses, were available from a previous project. All of the included individuals were cross checked for records of co-infection with other STI, in particular *N. gonorrhoeae*. The corresponding isolates of *N. gonorrhoeae* that were available were analysed by WGS and phylogenetic analysis identified potential clusters of gonorrhoea transmission. AMR determinants were elucidated from these isolates.

A total of 857 *men* and 193 women living with HIV were included. Around 20% of them were infected with gonorrhoea during the study period. Out of these, *N. gonorrhoeae* positive samples from 95 individuals were retrieved and analysed by WGS. Cross-reference of HIV and *N. gonorrhoeae* clusters were joined to identify clusters of co-transmission. The identification of transmission clusters will be valuable for policy making and for allocating resources to combat these diseases on these groups as well as to educate the population implicated.

The fellow joined the ongoing project at SSI. He participated in the design of the methodology, carried out the epidemiological data harmonization and cleaning, and contributed to the manuscript drafting.

Training modules

During the Introductory course, the fellows, grouped in teams, were given a research question for which they had to prepare a study plan and share it with their colleagues. The knowledge acquired in other modules has been important to define the microbiological and epidemiological methods of his projects. Furthermore, the Management, Leadership and Communication module was very valuable to improve the management of his projects.

Educational outcome: the fellow learnt to identify gaps in knowledge in Public health that can be addressed through research. He developed his skills in project management by being principal investigator and by being in charge of identifying tasks, drafting project proposals, protocol and timeline. He coordinated with the principal investigators in other countries and communicated with the different stakeholders.

3. Applied public health microbiology and laboratory investigations

Supervisors: Pikka Jokelainen, Rune Stensvold, Kurt Fuursted, Sofie E. Midgley

DNA extraction of faecal samples, genotyping of *Cryptosporidium* and interpretation of results

Recurrent outbreaks of cryptosporidiosis in veterinary students handling calves have been reported in the last years in several countries. During 2018 and 2019, a microbiological an epidemiological cohort study was carried out in Denmark to investigate risk factors responsible for these outbreaks (see section 1.1). Regarding laboratory investigations, stool samples from several cases and faecal samples from all calves used for the exercises were collected for real-time PCR and genotyping. Real-time PCR provides not only a qualitative result in terms of the infection status, but also a quantification of the intensity of infection. Genotyping using the *gp60* gene is commonly used for cryptosporidiosis outbreaks, especially those caused by *C. parvum*. The fellow carried out the DNA extraction from the samples and the preparation for real time-PCR. He interpreted the real time-PCR results and, for the positive samples, he carried out the *gp60* genotyping and subsequent alignments using MEGA software.

The laboratory results obtained showed a high prevalence of *C. parvum* in the calves used for the exercises, especially in those aged above seven days of age. The same genotype IIaA15G2R1 was found in the samples from the students and the calves, providing a microbiological link between the cases and the calves and, therefore, reinforcing the hypothesis of the zoonotic transmission. This result on its own would not be definitive as IIaA15G2R1 is a common genotype in livestock and humans. However, combined with the epidemiological investigation, it confirmed the main hypothesis that the calves were the source of the outbreaks among the students. Additionally, a dose response was observed, meaning that a higher parasite load in the calves' faeces was correlated with a higher probability of an outbreak occurring among the students (p value = 0.002).

In silico analysis of the WGS results obtained from the analysis of *Vibrio* spp. isolates

Vibrio bacteria are ubiquitous in aquatic and marine habitats. In the last years, countries in northern Europe have witnessed an increase in non-cholera *Vibrio* infections, especially during summer due to favourable conditions for *Vibrio* growth – brackish water and temperatures above 20 degrees. Due to the lack of comprehensive surveillance data available globally, an epidemiological and microbiological study of non-cholera *Vibrio* infections in the Nordic countries was established between four EUPHEM fellows (see section 2). As part of the microbiological study, 188 *Vibrio* isolates were analysed by WGS. The objectives were to elucidate if isolates from similar geographical areas and niches were related and to characterize the virulence, biofilm and AMR determinants of the isolates. The latter is of high public health importance as in the last years *Vibrio* isolates harbouring AMR genes against clinically relevant antibiotics have been found in the Baltic Sea. The fellow was involved in the analysis and interpretation of the results and he particularly led the analysis of the virulence results. This involved studying the databases and tools used for the WGS pipeline and an extensive bibliographic review about the existing knowledge in the area. He developed a script that would facilitate the analysis.

The results were useful to compare the presence of virulence and AMR determinants between different *Vibrio* species, to study potential correlations with the severity of the infections and to identify possible phylogenetic clusters.

Set-up and applicability of WGS for Hepatitis A virus

Hepatitis A virus (HAV) is commonly associated with foodborne outbreaks, but it can also be sexually transmitted and it has become an emerging matter of concern among the MSM community. Molecular characterization of HAV isolates has become crucial to tackle outbreaks. Currently, the strains involved in outbreaks, as well as those isolated as part of routine surveillance, are characterized by amplifying and sequencing a small conserved part of the genome.

WGS is not commonly used for HAV and a routine WGS protocol is not well established. As for many pathogens, it is expected that WGS could provide additional information in the study of HAV strains. Its higher discriminatory power could allow for the detection of minor variants, provide additional information in terms of the transmission, evolution of strains or biological consequences of mutations (virulence, survival of the virus, etc.), which could be have epidemiological and/or clinical relevance. It could also prove valuable in terms of preparedness for the future.

Therefore, a project was designed to test suitable WGS methods for HAV (either Illumina methodology or PCR-based sequencing) and to evaluate its usefulness for outbreak investigation and surveillance, such as increasing the discrimination in source identification or in long-term phylogenetic studies. The fellow carried out extensive

bibliographic review, designed the project and collaborated in the evaluation of different protocols used. He also designed the primers to be used for the PCR-based WGS strategy.

Unfortunately, the COVID-19 pandemic interrupted the project. It was therefore proposed that it could be continued by the next EUPHEM fellow at the training site.

Molecular characterization of *Giardia* isolates from hospital samples

The fellow helped Salem Belkessa, a PhD student who spent one year in the team working on *Giardia* infections. They used an assemblage-specific PCR assay to characterize *Giardia* strains isolated in patients from different hospitals from Algeria. Additionally, they amplified and sequenced the triosephosphate isomerase (*tpi*) gene of the isolates, a commonly used technique for subtyping of *Giardia* isolates. The *tpi* results was correlated with the demographic information available and it was used to establish phylogenetic relationships between the strains. This work was valuable to understand the strains circulating in Algeria and to elucidate whether different subtypes are more prevalent depending on age group or geographical origin of the patients within the country.

Training modules

During the Introductory Course and Outbreak Investigation module, the fellow was lectured on different laboratory techniques that can be used for the identification and characterization of pathogens. The advantages, disadvantages and limitations of each technique were discussed.

Educational outcome: the fellow expanded his skills in laboratory investigations by performing both "wet" and "dry" laboratory tasks with different pathogens. He identified the strengths, limitations, alternatives and complementary laboratory methods that could be used.

4. Biorisk management

Supervisors: Louise Lohse

Biosafety level 3 training

Since 2020, the SSI has become a One Health Institute. Therefore, routine work related to veterinary and zoonotic diseases is being established on site and diagnostic protocols have to be set up and fine-tuned. In this context, diseases with a huge impact on animals' health or commercial trade, as well as with zoonotic potential, have to be handled under biosafety level 3 (BSL-3) conditions. Diagnostic tests in place must present high sensitivity and specificity to ensure timely and accurate results. Neutralization tests have to be optimized, adapting protocols previously used in the former Danish veterinary reference laboratory facilities. The methods must be repeatedly tested against new references, virus controls and stored samples to detect possible flaws and ensure suitable functionality of the techniques.

The fellow participated in the BSL-3 tasks related to Vesicular Stomatitis, West Nile and Usutu viruses. In relation to his laboratory work, he subsequently revised the draft protocols, improved them and translated them to English.

Training modules

The Biosafety and Quality management module was cancelled.

Educational outcome: the fellow learnt about different protocols and regulations implemented to ensure biosafety and biosecurity. Additionally, through a visit to the Danish Food and Veterinary Administration, he learnt about how the different institutions and authorities work in this area.

5. Quality management

Supervisor: Susanne Schjørring, Flemming Scheutz

Ninth external quality assessment scheme for typing of Shiga toxin-producing *Escherichia coli* (STEC)

External quality assurance (EQA) is an important aspect of quality management systems. From a public health point of view, it provides objective evidence of testing quality, relevant to the laboratory itself but also physicians, patients, and health authorities; it allows for comparison of results among different laboratories by harmonizing detection and identification of pathogens; and it identifies areas that need improvement and specific training needs among participants.

Shiga toxin-producing *Escherichia coli* (STEC) strains are an important cause of food-borne illness worldwide and the total number of confirmed cases in the EU have been increasing the last years. Symptoms associated with STEC infections vary from mild to bloody diarrhoea, with abdominal cramps, but usually without fever. In 5-10% of the cases, STEC infections can additionally result in a haemolytic uremic syndrome (HUS) characterised by acute kidney failure, haemolytic anaemia and thrombocytopenia. Human pathogenic STEC may possess a number of virulence factors that play a critical role in the development and progression of the disease. There are a large number of serotypes of *E. coli* identified as shiga-toxin producers. Public health microbiology laboratories play a central role in the surveillance of STEC infections, as well as in the preparedness for responding to outbreaks and in providing scientific evidence for the implementation of prevention and control measures.

The International Centre for Reference and Research on *Escherichia* and *Klebsiella* at SSI organises an annual EQA for the national Public Health reference laboratories in the EU/EEA and invites non-EU countries to participate as self-funded participants. The overall aim of this EQA is the harmonization of the typing methods used for STEC, in order to produce comparable typing data for STEC strains between laboratories.

The fellow participated in the 2018-2019 STEC EQA for self-funded participants. The EQA included the following methods: O:H serotyping, detection of virulence genes (*aaiC*, *aggR*, *eae*, *stx1* and *stx2*) and subtyping of the *stx* genes of the EQA isolates, as well as cluster analysis (by Pulsed Field Gel Electrophoresis [PFGE] and/or WGS) of a different set of isolates. Fourteen public health national reference laboratories participated in at least one of the EQA parts.

Using Bionumerics and Excel, he analysed the data and evaluated the results, comparing them with the expected results for the STEC isolates evaluated. He generated separate feedback reports for each laboratory and a global report with the results from all self-funded participants. In addition, he collaborated in the organization parts: drafting and revising the online results forms and communicating with the participants for troubleshooting. For the first steps of the EQA (invitation letter, processing and shipping of the isolates), he participated as an observer.

Overall, the scores of the EQA were highly satisfactory. Results showed a need to reinforce the methodology to detect uncommon serotypes. There is an increase tendency towards using WGS as a replacement for phenotypic methods and PFGE, but there is still a large number of participants worldwide not implementing WGS. As inter-laboratory comparison of microbiological results across borders is fundamental in public health and food safety, it is critical that laboratories pursue efforts to develop capacity building, harmonise protocols and participate in EQA schemes.

Training modules

The Biosafety and Quality management module was cancelled.

Educational outcome: by participating in the organization of an EQA, the fellow learnt about quality management regarding all aspects – science, administration and logistics. A thorough organization at these three levels is necessary to ensure a smooth development of the EQA and a successful engagement of the participants now and in the future.

6. Teaching and pedagogy

Problem based learning (PBL) exercise: Importance of Antimicrobial Resistance as a Public Health Threat

During the Introductory course, the EUPHEM fellows were given a question, *Importance of AMR as a Public Health Threat*, for which they should prepare a teaching delivery for a specific audience. During the following week, the fellows worked as a team and in subgroups. The subgroup of the fellow worked in presenting the principles of AMR, current context and challenges, with a focus on the One Health approach. A plenary lecture was prepared, together with the learning outcomes and a final assessment for the audience. The lecture was delivered and appraised by the EUPHEM supervisors and coordinators attending it.

Facilitation of a Case study during the Outbreak Investigation Module

The fellow was invited to facilitate the case study *An outbreak of hepatitis A in Europe*, together with the EUPHEM fellows Carina Brehony and Maximilian Riess and the ECDC expert Erik Alm. The objectives of this case study were to analyse genomic outbreak data, to evaluate the quality of sequence data obtained by Sanger sequencing, to be aware of different databases and how to utilize them, to determine the importance of good sequence alignment, to understand basics behind phylogenetic analyses and to construct and interpret a phylogenetic tree in the context of an outbreak investigation.

The facilitators explained the case study, and the tasks to be performed. During the exercise, the participants were divided in small groups working together. The facilitators moved around the room helping the fellows and explaining in plenary for all the participants when relevant.

To improve the case study for the following years, after the activity the three EUPHEM fellows revised the case study and prepared an evaluation report that included the results of the evaluation carried out by the participants in the room.

Plenary lectures at the Rey Juan Carlos University of Madrid

In March 2019, the fellow was invited to present two lectures, one hour each, about AMR and One Health at the Rey Juan Carlos University of Madrid (Spain). The audience of the lecture were second year undergraduates from Environmental engineering and Food & Science Technology degree. Around 40 students attended each lecture.

Before the teaching, the fellow discussed with the coordinator of the subjects about the current level of the students, the approach to be used for the lesson and any specific aspects that should be included. The main suggestion was to ensure to mention why the topic is relevant for the students and for their future career. In preparation for the lecture, the fellow partially used previous material prepared by him for other lectures, getting ideas as well of presentations received during the EUPHEM fellowship. When showing examples about the current situation of AMR and certain infectious diseases in Europe and worldwide, official websites from the ECDC, WHO, EFSA (European Food Safety Authority) and CDC (Centers for Disease Control and Prevention) and other institutions were used as reference.

During the teaching, a PowerPoint presentation was used. It contained basic concepts, graphs, pictures and references to current and historical events. It also included slides to interact with the students. Questions posed by the students were answered and debated all along the presentation.

Students were interested, motivated and participative. The PDF of the presentation was shared with the students. The last slide included a QR code to a short evaluation form that consisted of ten questions, ranked from 1 ("I totally disagree") to 5 ("I totally agree"). For nine out of ten questions, answers 4 and 5 grouped over 89% of all the answers collected. The language, teaching style and material used by the teacher were evaluated with a 4,8/5 and, overall, the global satisfaction of the lecture was also 4,8/5. A report of the activity was prepared as well. Both the teacher and coordinator agreed to keep the lecture for the following years. Unfortunately, in 2020 it had to be cancelled due to the COVID-19 pandemic.

Lecture at the at the *Parasitic Zoonoses and One Health control approaches* MSc course of the University of Copenhagen

The fellow prepared and presented a lecture based on the zoonotic outbreaks of cryptosporidiosis among veterinary students. He answered the students' questions and engaged with them in fruitful discussions.

Mentoring of a PhD student

During his EUPHEM fellowship, the fellow has shared office with different students. In particular, he helped Rune Stensvold, main EUPHEM supervisor, in mentoring Salem Belkessa. The fellow trained the PhD student in laboratory procedures (i.e. PCR, electrophoresis, *in silico* analysis) and scientific writing and was co-author of the student's manuscript.

Training modules

During the Introductory Course, the fellows were lectured and trained in how to prepare teaching deliveries efficiently. The Project Review module was valuable to improve the presentation skills and to learn to give and receive feedback.

Educational outcome: the fellow has always been passionate about teaching and capacity building and these activities trained him further in how to effectively carry out these duties and which components should be considered when preparing a teaching activity. He especially learnt about how to evaluate the impact of the teaching activity and to reflect on it for the future.

7. Public health microbiology management

Management and leadership of projects

In several projects the tasks of the fellow included substantial management. He was the project manager of the *Cryptosporidium* outbreak investigation. For the multi-country *Vibrio* infections research project, he was the principal investigator and project manager from Denmark. In both projects, besides carrying out most of the

scientific and analytical work, he was in charge of engaging with the stakeholders involved (e.g. SSI staff from other departments, University, regional clinical microbiology laboratories) as well as coordinating meetings, tasks and timelines. The fellow was also the team coordinator for the PBL exercise carried out by all EUPHEM fellows during the Introductory Course.

Additionally, through these projects the fellow improved his skills in teamwork, time management, oral and written communication and problem-solving.

Deployment at the WHO European regional office (WHO-EURO), Denmark

In March 2020, the fellow started his deployment at the WHO-EURO office to support the COVID-19 international response. Due to the public health measures implemented, most of the deployment was carried out remotely by the fellow. The second half of the deployment was carried out splitting his time and tasks between the WHO and the SSI based on each institution's demands. Therefore, this deployment significantly trained the fellow in management skills related to effective distance communication with colleagues and managers, use of software and tools for online meetings and sharing of sensitive content, working with flexibility and welcoming rapid change of priorities.

Participation in the organization of modules and conferences

The fellow participated in the preparation of the social agenda for the Multivariable Analysis Module (Madrid, Spain, 2019). Additionally, he was part of the organizing committee for the Project Review Nordic mini-module (Copenhagen, Denmark, 2019), for which he prepared the scientific programme, engaged with participants and facilitators and ensured that logistics needed were available.

In 2020, he was invited to be part of the Scientific Committee of the One Health European Joint Programme (OHEJP) Annual Scientific Meeting, migrated from face-to-face to an online event due to COVID-19 pandemic. He participated in online meetings with the rest of the Committee. He evaluated the abstracts submitted to decide whether the communications should be considered for poster, oral presentation or none. During the event, he evaluated the oral presentations and the 3-minute-thesis-presentations by PhD students, scoring the communications according to different criteria and providing the participants with feedback about their performance. This event trained the fellow in the scientific and administrative tasks to be managed during conferences and in the preparation of online and face-to-face events.

Presentation to the ECDC Director and Chief Scientist

During the Management, Leadership and Communication module, the fellow and his team prepared a presentation 'Improving the ECDC fellowship - Visions from the fellows', to discuss with the ECDC Director, Chief Scientist and audience about the strengths and weaknesses of the EUPHEM-EPIET programme, and how it can be improved for the future cohorts.

Training modules

During the Introductory Course and Project Review modules, the fellow was trained in aspects of effective communication as well as in the presentation of future activities, sharing of results and engaging with stakeholders in a constructive way. The Management, Leadership and Communication in Public Health module trained the fellow in how to be effective managers, the understanding of the different personalities of colleagues and how to address them, time management, problem solving and effective communication with different stakeholders.

Educational outcome: the fellow developed skills in management and leadership to carry out tasks of different nature and to effectively engage with different stakeholders. Additionally, the fellow also progressed by approaching team building, networking, time management and conflict solving during his fellowship.

8. Communication

Publications

1. **Thomas-Lopez D**, Müller L, Vestergaard LS, Christoffersen M, Andersen AM, Jokelainen P, Agerholm J, Stensvold CR. Veterinary students have a higher risk of contracting cryptosporidiosis when calves with high fecal *Cryptosporidium* loads are used for fetotomy exercises. *Applied and Environmental Microbiology*. 2020 Sep 17;86(19):e01250-20. DOI: 10.1128/AEM.01250-20
2. Cassell K*, **Thomas-Lopez D***, Kjelsø C, Uldum S. Provincial trends in Legionnaires' disease are not explained by population structure in Denmark. *Eurosurveillance*. Accepted. *Equal contribution

3. Amato E*, Riess M*, **Thomas-Lopez D***, Linkevicius M* *et al.* Multi-country occurrence of non-toxigenic cholera and non-cholera *Vibrio* infections in Nordic countries and countries bordering the Baltic Sea in 2018. In preparation. *Equal contribution
4. Rose A, Kissling E, Emborg HD, Larrauri A, McMenamin J, Pozo F, Trebbien R, […], **European Ive Group**. Interim 2019/20 influenza vaccine effectiveness: six European studies, September 2019 to January 2020. *Eurosurveillance*. 2020. DOI: 10.2807/1560-7917.ES.2020.25.10.2000153
5. Belkessa S, **Thomas-Lopez D** *et al.* Molecular characterization of *Giardia intestinalis* in children and adults sampled in the Algiers metropolitan area. Submitted.

Reports

1. Surveillance report: Annual summary on the status of Legionnaires Disease in Denmark, 2019.
2. Surveillance report: Determination of the age-specific and age-standardised notification rates of Legionnaires' Disease in Danish provinces, 2015 to 2018.
3. Site visit report: Observation of veterinary students during fetotomy exercises, University of Copenhagen, 27/11/2018.
4. Outbreak report: *Cryptosporidium parvum* outbreak among veterinary students, University of Copenhagen, 2018-2019.
5. Outbreak report: Outbreak of gastroenteritis at Copenhagen Airport, 31/12/2019.
6. External quality assessment scheme for typing of Shiga toxin-producing *E. coli* (STEC), self-funded participants, 2018-2019.
7. Survey on national surveillance systems for vibriosis and *Shewanella* spp. infections in EU/EEA countries. 23/12/2019 (ECDC report pending of publication).
8. BSL-3 protocol: Vesicular Stomatitis Virus Neutralisation test and Titration test.
9. BSL-3 protocol: Sampling, extraction and PCR of material from dead birds for West Nile and Usutu Virus.
10. COVID-19 Internal WHO report: Social and Physical Distancing Measures Implemented in Europe to Slow the Spread of COVID-19. May 2020. Not released.

Conference presentations

1. Poster presentation: Amato E*, Riess M*, **Thomas-Lopez D***, Linkevicius M* *et al.* Vibriosis in Northern Europe: an emerging public health threat? ESCAIDE 2020. November 2020.
2. Accepted poster: Belkessa S, **Thomas-Lopez D** *et al.* First study on *Giardia intestinalis* assemblages in Algerian individuals. The 30th European Congress of Clinical Microbiology and Infectious Diseases (ECCMID 2020), abstract no. 4733 in the abstract booklet (NB: meeting cancelled).
3. Oral communication: **Thomas-Lopez D** *et al.* Reoccurring zoonotic cryptosporidiosis outbreaks in veterinary students in Denmark, a combined epidemiological and microbiological study during the full academic year 2018-2019. ESCAIDE 2019, November 2019.
4. Oral communication: **Thomas-Lopez D** *et al.* Outbreaks of cryptosporidiosis in veterinary students working with calves, Denmark 2018-2019. CSBSP8 & EVPC2019 (8th Conference of the Scandinavian-Baltic Society for Parasitology and the Annual Meeting of the European Veterinary Parasitology College), October 2019.

Other selected presentations

1. Oral presentation at the MSc course *Parasitic Zoonoses and One Health control approaches* of the University of Copenhagen, 30/09/2019.
2. "Improving the ECDC fellowship - Visions from the fellows" Presentation to the ECDC Director and Chief Scientist during the Management, Leadership and Communication module, 14/02/2020.
3. Presentation at the ECDC Webinar on EPIET/EUPHEM/EAP fellows activities in relation to the COVID-19 pandemic, 06/04/2020.
4. Periodical presentations on projects at the SSI EPIET-EUPHEM forum, 2018-2020.

Other

1. Module Guide and Evaluation report for the 2019 Project Review Nordic mini-module. March 2019.
2. Self-created report: Removal of Non-pharmaceutical interventions after COVID-19 pandemic. April 2020.
3. *EUPHEM: SALUD PÚBLICA, EUROPA Y COVID-19.* Interview to another EUPHEM fellow for the monthly bulletin NoticiaSEM as part of the activities carried out with the Group of Young Researchers of the Spanish Society for Microbiology (JISEM-SEM). May 2020.

Training modules

Different sessions during the modules trained the fellows in how to effective communicate. This included scientific writing using the argument matrix and preparation of posters and oral communications. Additionally, the Management, Leadership and Communication in Public Health module was valuable to learn about how to communicate with colleagues, managers, team members, the media or the general public.

9. EPIET/EUPHEM modules attended

1. EPIET/EUPHEM Introductory Course; 24th September – 12th October 2018; Spetses, Greece
2. Outbreak Investigation Module; 03rd – 07th December 2017; Berlin, Germany
3. Nordic Project Review Minimodule, 11th-12th March 2019; Copenhagen, Denmark
4. Multivariable Analysis Module; 25th – 29th March 2019; Madrid, Spain
5. Rapid Assessment and Survey Methods Module, 13th – 17th May 2019, Athens, Greece
6. Project Review Module, 26th – 30th August 2019, Lisbon, Portugal
7. Management, Leadership & Communication in Public Health Module; 10th – 14th February 2020, Stockholm, Sweden
8. Vaccinology Module, May–June 2020, Online

10. Other training

1. Workshop for the National Reference Laboratories on the training of WGS use for Antimicrobial resistance analysis. European Reference Laboratory, Copenhagen, September 2019.
2. Introduction to R course. EPIET Alumni Network, pre-ESCAIDE activity. Stockholm, November 2019.
3. ESCMID Observership at WHO. Copenhagen, December 2019.
4. Visit to the Danish Food and Veterinary Administration (FVST). Glostrup, January 2020.
5. Go.Data Advanced training. May 2020.
6. Online courses on the ECDC Virtual Academy (EVA):
    a. Rapid Risk Assessment – Pilot edition. December 2018.
    b. Influenza bioanalytics. December 2019.
7. Online courses on the WHO and the United Nations online platforms:
    a. BSAFE Security Awareness Training. May 2019.
    b. The Global Outbreak Alert and Response Network (GOARN). May 2019.
    c. Working with GOARN in the field. May 2019.
    d. WHO Emergency (WHE) Operational Readiness. September 2019.
    e. WHO Pre-Deployment Pack: GO 2.0. February 2020.
    f. WHO Incident Management System (Tier 1): Introduction to Health Sector Emergency Response Management. February 2020.
    g. WHO Incident Management System (Tier 2): Working in WHO's Incident Management System
    h. Infection Prevention and Control (IPC) for Novel Coronavirus (COVID-19). March 2020.
    i. UN Human Rights and Responsibilities. March 2020.
    j. UN To Serve With Pride - Zero Tolerance. March 2020.
    k. UN Prevention of Harassment, Sexual Harassment and Abuse of Authority. March 2020.
    l. Introduction to Go.Data – Field data collection, chains of transmission and contact follow-up. April 2020.

Discussion

Coordinator's conclusions

One of the main goals of the EUPHEM programme is to expose fellows to diverse and multidisciplinary public health experiences and activities, thus enabling them to work across different disciplines. This report summarises all activities and projects conducted by Daniel V. Thomas López during his two-years fellowship (cohort 2018) as an EU-track fellow at the Statens Serum Institut (SSI) of Denmark. The projects described in this portfolio demonstrate the breadth of the public health microbiology work of Daniel. Daniel's undiscussed capacities for networking and enthusiasm has brought him to engage in a multi-country research project (Non-toxigenic *V. cholerae* and non-cholera *Vibrio* infections in Nordic countries) that has contributed significantly to enlarge his management skills and his understanding on the challenges and possibilities attached to a cross borders public health project. He has been intensively involved in outbreak investigation as testified by the Recurring *Cryptosporidium* outbreaks in veterinary students - project. He has been able to cover all the EUPHEM core competencies with ad hoc projects or activities and had the opportunity to contribute to the response to Covid-19 pandemic by an International assignment being deployed at the WHO European regional office (WHO-EURO), Denmark. Daniel had very good teaching experience that covered different audiences: from fellows and coordinators to university students and mentoring of a graduate student in the lab. The EUPHEM Coordinator concludes that the fellow has succeeded in performing all his tasks to a high standard and with a good professional attitude. We wish the fellow every success in his future career as a public health microbiologist.

Supervisor's conclusions

During his fellowship at the Statens Serum Institut (SSI), Daniel has acquired and demonstrated thorough understanding and conduct of all major core domains of the EUPHEM programme, expanding on these competencies within public health microbiology field epidemiology, outbreak investigation and surveillance activities.

Daniel has been passionate about his fellowship, and he has strived to make the most of it, eagerly engaging in as many as tasks as he had the chance to collaborate on without losing control of his tasks. He has proved to be competent both in contributing to ongoing work where help was needed as well as in leading those projects he was fully in charge of, both in bacteriology, parasitology and virology. He has had close collaboration with other EUPHEM and EPIET fellows and with the Epidemiology and Clinical Microbiology departments, thereby being central to strengthening the collaboration among different experts and departments at SSI.

His duties have included project design and drafting, 'wet' and 'dry' laboratory work, manuscript and report preparation, and communication with the different stakeholders involved. He is a highly responsible, well-respected, and well-liked project manager and he performs his numerous tasks efficiently, timely, and satisfactorily.

Without neglecting his scientific nor his administrative responsibilities, and in addition to an intense traveling schedule for his EUPHEM training, Daniel has been able to run in parallel his work in different projects and teams with unexpected situations where he was willing to jump in, such as outbreaks. For instance, during the COVID-19 pandemic, Daniel quickly responded to a GOARN request and was deployed for eight weeks to the WHO European regional office, where he supported the Incident Management System team.

Daniel is highly skilled in teaching and training. He has delivered university lectures and has been very positively evaluated by the students for his pedagogical methods, his engaging capacity, and his enthusiasm. He has also actively collaborated in the training of graduate students through scientific discussions, laboratory work and manuscript preparation. This ability to engage with different audiences is part of Daniel's outstanding communication capacity, which he proves every time he presents his work at conferences, science dissemination sessions, or at other events.

Finally, Daniel demonstrates good social skills, he adapts easily to new living and working environments and works with high stability and efficiency even when everything is new.

Personal conclusions of fellow

I heard about the EUPHEM programme when I was half-way through my PhD and I immediately felt it would be an amazing opportunity to apply my knowledge and experience in academic research, food safety and teaching to the area of public health. This fellowship has given me the chance to work with a wide range of pathogens, from different scopes and under the guidance of leading experts in their fields. Its learning-by-doing format is unique. I have made the most out of every module, where I have learnt so much in so little time, and in all the modules I have enjoyed an environment of motivation, partnership and friendship.

Certainly, for me the most important part of the ECDC Fellowship is the international network of public health professionals that it creates throughout the years. Sharing modules, projects, dinners and time with the rest of the fellows as well as with the facilitators and organizers has been amazing.

Because of all of this, now at the end of the fellowship I cannot avoid to experience a bittersweet sensation. I see how the COVID-19 pandemic has had a significant impact on my fellowship. Certain projects had to be reduced or cancelled and, most importantly, our modules had to be unavoidably switched from face-to-face to online versions. While the pandemic has clearly evinced how critical public health professionals are, I feel that it has taken away a part of the wonderful experience I was enjoying as an ECDC fellow.

Acknowledgements of fellow

First of all I would like to thank the ECDC for having selected me as a EUPHEM fellow.

I would like to thank my site supervisors, Rune Stensvold and Lasse Rasmussen, as well as my colleague Pikka Jokelainen, for greatly mentoring and supporting me through these two years, for being so flexible and helpful with my plans and ideas and for always looking for ways to improve my time at SSI. Thank you to all my project supervisors for having dedicated time to mentor me, as well as to the rest of the SSI fellows for their friendliness.

Thank you to my Frontline Coordinator as well as to all the modules facilitators and organizers, because their hard and inspiring work is needed to make our fellowship as great as it is.

Finally, I thank my EUPHEM/EPIET/EAP fellows of cohort 2018 for these wonderful two years. It will be longer than expected before we see each other, but until then and beyond, I will keep a smile when I think about our wonderful time spent together. We are the example that Europe needs!